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# DECLARATION

I, Ryuichi YAMADA, a Japanese Patent Attorney registered No. 7898 having my Business Office at Toranomon Sugai Bldg., 2F, 18-16 Toranomon 3-chome, Minato-ku, Tokyo, Japan, solemnly and sincerely declare:

That I have a thorough knowledge of Japanese and English languages; and

That the attached pages contain a correct translation into English of the specification of the following Japanese Application:

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Applicant(s)
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Signed this 29th day of July, 2010.

Ryuichi YAMADA

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G09F 9/37

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| <ARTICLE> | Abstract | 1 |
| <GENERAL POWER NO.> | 9704371 | |

[Document]

Claims

[Claim 1]

A particle movement-type display apparatus comprising:

a first substrate and a second substrate with a predetermined spacing between said first and second substrates;

a partition wall member disposed in the spacing between said first and second substrates:

a plurality of particles disposed in the spacing surrounded by said first and second substrates and the partition wall member;

a plurality of pixel portions formed by a plurality of electrodes disposed internally in contact with said spacing; and

wherein said apparatus further comprises a structure, which has a projection portion having a height substantially equal to a height of said partition wall member and a recess portion in which a part of the particles are capable of being accommodated, disposed in at least a part of an outer peripheral portion around a display portion comprising a plurality of pixel portions.

[Claim 2]

A particle movement-type display apparatus

according to Claim 1, wherein said projection portion is formed in a mesh shape, a straight line shape or a curved-line shape, a dot shape, a shape such that said display portion is surrounded by said projection portion with a recess portion, a double cross shape, a cross shape or a combination of these shapes.

[Claim 3]

A particle movement-type display apparatus according to Claim 1 or 2, wherein a minimum line width or diameter at an upper surface of said projection portion is not more than approximately 10 times of the diameter (particle size) of said particles.

[Claim 4]

A particle movement-type display apparatus according to any one of Claims 1 to 3, wherein two kinds of electrode layers are formed in at least a part of said structure and peripheral portion of said structure.

[Claim 5]

A process for producing a particle movement-type display apparatus as defined in Claim 4, wherein when each pixel (portion) is sealed by disposing said second substrate so as to cover said partition wall member and said structure, the sealing is performed while applying an AC voltage between two kinds of said electrode layers.

[Claim 6]

A process for producing a particle movement-type display apparatus as defined in Claim 5, wherein each pixel (portion) is sealed by said second substrate so as to cover said partition wall member and said structure, the sealing is performed while applying an AC voltage between the plurality of said electrodes, disposed internally in contact with the spacing.

[Document]

Specification

[Title of the Invention]

Particle Movement-type Display Apparatus

[Field]

The present invention relates to a particle movement-type display apparatus, such as an electrophoretic display apparatus, for effecting display by moving the particles.

[Prior Art]

In recent years, study on reflection-type display apparatuses using no backlight has been actively made. Of these display apparatuses, a particle movement-type display apparatus attracts a lot of attention. The particle movement-type display apparatus includes, e.g., a pair of substrates with a predetermined spacing therebetween a plurality of particles disposed in the spacing, and a pair of electrodes disposed internally in contact with the spacing. The particle movement-type display apparatus has various advantages, such as a high display contrast, a wide viewing angle, a display memory characteristic, unnecessity of a backlight and a polarization plate, etc., compared with a liquid crystal apparatus.

Generally, the particle movement-type display apparatus effects display by applying an electric

field or the like to each pixel, between the pair of substrates, at which a certain amount of particles are disposed, thereby to move the particles within each pixel. For this purpose, ordinarily, a plurality of particles are disposed between two substrates on which a pixel electrode formed at each pixel and a common electrode for all the pixels are formed. The particles have a particle size of approximately 0.5 - 5 μm. In order to prevent movement of the particles between adjacent pixels to cause nonuniform distribution, a partition wall is formed at each pixel.

In the case of such a particle movement-type display apparatus having a partition wall structure, the particles are generally filled between partition wall members after all the members such as the electrodes and the partition wall members are formed on one of the substrates, and then the particles are sealed in each pixel by the other substrate (step), as described in Patent Document 1 and Patent Document 2.

Patent Document 1: Japanese Laid-Open Patent Application No. Hei 05-307197

Patent Document 2: Japanese Patent No. 2612472

[Disclosure of the Invention]

[Problems to be Solved]

However, in the sealing step in a particle movement-type display apparatus, it is necessary to prevent the particles from being entered between the

other substrate, a partition wall and an adhesive fixing portion formed at the outer peripheral portion of a display portion. If the particles enter between the other substrate, a partition wall and an adhesive fixing portion formed at the outer peripheral portion of a display portion, the sealing of the display portion cannot be performed completely, so that there is a possibility that the particles are moved to other pixel portions or outside the display portion. As a result, the display of display apparatus cannot be satisfactorily performed in some cases. However, the particles is prevented from being entered between the other substrate, a partition wall and an adhesive fixing portion formed at the outer peripheral portion of a display portion after the multiple particles are disposed and distributed substantially uniform in each pixel portion in the display portion, so that it is not easy to seal the display portion. Therefore, a method for further improving the yield rate on the process for producing the particle movement-type display apparatus has been desired.

[Means for Solving the Problems]

The present invention was made in consideration of the above described problems, and therefore, according to a principal aspect of the present invention, there is provided a particle movement-type display apparatus comprising: a first substrate and a

second substrate with a predetermined spacing between the first and second substrates; a partition wall member disposed in the spacing between the first and second substrates: a plurality of particles disposed in the spacing surrounded by the first and second substrates and the partition wall member; a plurality of pixel portions formed by a plurality of electrodes disposed internally in contact with the spacing; and wherein the apparatus further comprises a structure, which has a projection portion having a height substantially equal to a height of the partition wall member and a recess portion in which a part of the particles are capable of being accommodated, disposed in at least a part of an outer peripheral portion around a display portion comprising a plurality of pixel portions. The structure may be disposed in a part of the outer peripheral portion. However, the structure may be preferably disposed in all the outer peripheral portion of the display portion which is advantageous in terms of an airtightness and strength of the display portion.

The present invention was made in consideration of the above-described problems, and therefore, according to another aspect of the present invention, there is provided a process for producing a particle movement-type display apparatus, wherein when each pixel (portion) is sealed by disposing the second

substrate so as to cover the partition wall member and the structure, the sealing is performed while applying an AC voltage between two kinds of the electrode layers. In this case, each pixel (portion) is sealed by the second substrate so as to cover the partition wall member and the structure, the sealing is performed while applying an AC voltage between a pixel electrode and the common electrode, disposed internally in contact with the spacing.

[Advantageous Effect]

As described above, according to the present invention, a structure, which has a projection portion having a height substantially equal to a height of a partition wall member and a recess portion in which a part of the particles are capable of being accommodated, disposed in at least a part of an outer peripheral portion around a display portion. As a result, it is possible to easily provide a particle movement-type display apparatus which can suppress the defect.

[Description of the Preferred Embodiment]

Hereinbelow, embodiments of the present invention will be described with reference to Figure 1 to Figure 6.

A structural example of a representative particle movement-type display apparatus according to the present invention will be described with reference

to Figures 1(a) and 1(b). In this embodiment of a particle movement-type display apparatus, as shown in Figure 1(a), mesh-shaped portion wall 2 and a structure 3 are formed on a first substrate 1. In Figure 1(a), only 4 pixels (pixel portions) 4 are indicated but a multiplicity of pixels are ordinarily formed in a matrix form in an actual display apparatus. Each pixel portion 4 is surrounded by the partition wall 2 so as to separate it from adjacent pixels, and at the periphery of the display portion constituted by the plurality of pixel portions 4, the mesh-shaped structure 3 is disposed adjacent to the pixel portions 4.

As shown in Figure 1(b) which is a sectional view along A-A' line of Figure 1(a), in each pixel 4, an insulating liquid 11 and a plurality of electrophoretic particles 5 dispersed in the insulating liquid 11 are disposed. Upper surfaces of the mesh-shaped partition wall 2 and structure 3 are closely covered with the second substrate 12, and the second substrate 12 is bonded and fixed to the first substrate 1 with an adhesive at a peripheral frame portion to seal each pixel 4. In Figure 1(b), a state of bonding and fixing with the adhesive is not shown, and Figure 1(a), the second substrate 12 is not shown. In order to improve airtightness and strength of the display portion, a mesh density of the structure 3 on

which a larger force is exerted is larger than a mesh density of the partition wall 2.

The structure 3 has the recess portion 3b, capable of accommodating the particles 5, and the projection portion 3a which is formed to have a height substantially equal to a height of the partition wall 2 generally formed at the display portion or is formed so that the height of the projection portion 3a is moderately decreased from a portion adjacent to the display portion toward an outer portion. This is because an adhesive property between the second substrate 12 and an upper surface of the projection portion 3a of the structure 3 is improved to ensure airtightness. A line width at the upper surface of the projection portion 3a of the structure 3 may preferably be not more than approximately 10 times, more preferably not more than approximately 5 times, of the diameter of the electrophoretic particles 5 so that the electrophoretic particles 5 are less liable to stop on the upper surface of the projection portion 3a in a production step of the display apparatus. This is also true for a line width at the upper surface of the mesh-shaped partition wall 2. The line width at the upper surface of the projection portion 3a may appropriately determined while taking both of a required strength of the structure 3 and a degree of difficulty in stopping the electrophoretic particles 5

on the upper surface of the projection portion 3a into consideration.

Further, in the structure 3 forming area, a density of the projection portion 3a of the structure 3 is not particularly limited but may preferably be not more than approximately 50 % in order that the electrophoretic particles 5 are less liable to stop on the upper surface of the projection portion 3a. However, in view of the strength of the structure 3, the density is required to be not less than approximately 5 %. Further, a mesh density of the projection portion 3a of the structure 3 may be increased toward outside of the structure 3. This is because an airtightness-improving effect by the sealing is achieved. In the case where the line width of the projection portion 3a of the structure 3 at the upper surface is relatively large, e.g., approximately 10 times of the diameter of the electrophoretic particles 5, at the time of sealing the display portion by the second substrate 12, it is preferable that an AC voltage is applied so as to drop the particles 4 from the upper surface of the projection portion 3a with reliability, as described later. When the line width is relatively small, it is not necessary to apply the AC voltage at the time of the sealing by the second substrate 12 in some cases.

As a shape of the projection portion 3a of the

structure 3 in the present invention when viewed from the above, other than the mesh shape, it is possible to use a straight line shape as shown in Figure 2 such that line-shaped projection portions 3a are extended from the inside to the outside and in parallel with each other so as to provide recess portions 3b between adjacent projection portions; a shape as shown in Figure 3 such that the display portion is surrounded multiply (double in Figure 3) by rectangular projection portions 3a with a recess portion 3b therebetween; a dot shape as shown in Figure 4 such that the display portion is substantially surrounded by a large number of dots at the substantially same distribution density with recess portions 3b therebetween; a curved-line shape such as wavy shape; a double cross shape; a cross shape; a combination of these shapes; etc. However, the shape of the projection portion 3a is not limited thereto. Further, the meshes, the lines, the dots, and the like may have a substantially uniform pitch but may preferably have such a pitch that it is decreased from the display portion area toward the outer portion so as to increase the strength of the outer portion by increasing a proportion of the projection portion 3a of the structure 3 viewed from the above may be regular or irregular and the pattern shape may be closed in an in-plane direction as in the cases of the

mesh shape shown in Figure 1 and the surrounding shape shown in Figure 3 or open in the in-plane direction as the cases of the straight line shape shown in Figure 2 and the dot shape shown in Figure 4. In the case of the closed projection portion 3a, when the sealing is performed by covering the display portion with the second substrate 12, the display portion is sealed multiply in the in-plane direction of the substrate, thus being excellent in airtightness. In the case of the opened projection portion 3a, even when the insulating liquid 11 and the electrophoretic particles 5 flow into the recess portion 3b of the structure 3, a remaining amount at the recess portion 3b is finally reduced. Further, the structure 3 does not need to be formed at the entire periphery of the display portion area as shown in Figure 6. The projection portion described above may be a honeycomb shape which is advantageous in terms of a strength of the resultant display apparatus.

In the structure 3, an electrode layer 6 for structure 3 may preferably be formed at a surface or the inside of the projection portion 3a, between the substrate and the projection portion 3a, in the neighbourhood of the projection portion 3a (i.e., within the recess portion 3b of the structure 3), etc. The electrode layer 6 for structure 3 may be connected with a common electrode 7 described later. Further,

at a portion, on the substrate 1, surrounded by the projection portion 3a of the structure 3, i.e., the recess portion 3b of the structure 3, a non-display area electrode 8 located outside the display area is formed. These electrodes 6 and 8 are used in a production step of the display apparatus as described later.

At each portion 4 in the display area, a pixel electrode 9 and the common electrode 7 are disposed. For example, in the case of a display apparatus for effecting display by moving the electrophoretic particles 5 in a direction substantially in parallel with the in-plane direction of the substrate, the pixel electrode 9 is disposed on the first substrate 1 at each pixel 4. In this case, the pixel electrode 9 also functions as a light-reflection layer. For this purpose, it is preferable that a scattering layer is disposed on an observer side of the reflection layer or the reflection layer is provided with a surface unevenness to cause irregular reflection. The pixel electrode 9 is connected with a switching element 10, such as a thin film transistor (TFT), formed on the first substrate 1. The common electrode 7 is formed so as to cover the neighbourhood or the surface of the partition wall 3. By these pixel electrode 9 and common electrode 7, the plurality of electrophoretic particles 5 dispersed in the insulating liquid 11

confined in each pixel 4 are controlled and moved.

The display is effected by applying a voltage between the pixel electrode 9 and the common electrode 7 to move the electrophoretic particles 5 therebetween. As shown at a left portion 4 in Figure 1(b), by disposing the electrophoretic particles 5 on the pixel electrode 9, it is possible to display the color of the particles. On the other hand, as shown at a right portion 4, the electrophoretic particles 5 are collected to the common electrode 7, whereby incident light is reflected by the surface of the pixel electrode 9 and scattered by the scattering layer. In such an active matrix driving method using a plurality of pixel circuit each including the switching element 10, each pixel circuit is disposed at an intersection of an associated data line and an associated scanning line. It is also possible to control and move the electrophoretic particles by a simple matrix driving method. In the simple matrix driving method, a plurality of line-shaped first electrodes and a plurality of line-shaped second electrodes intersect with each other to form a plurality of pixels each at an intersection, and the electrophoretic particles are filled in each pixel to which an electric field is selectively applied to control and move the particles.

In order to effect white/black display by using

the above described electrophoretic display apparatus, the electrophoretic particles 5 is colored black and is driven in a shutter manner. On the other hand, in order to effect color display, the electrophoretic particles or other members may appropriately be colored. For example, by using black electrophoretic particles 5 and forming a color filter layer on the surface of the pixel electrode 9, it becomes possible to effect color display.

An embodiment of a representative production process of the particle movement-type display apparatus in this embodiment will be described with reference to Figures 5(a) to 5(d).

First of all, in a display area in the first substrate 1, the switching element 10 (e.g., TFT) and wiring (not shown) are formed and thereon, an insulating layer provided with an unevenness and a contact hole and the pixel electrode 9 is formed with respect to the switching element 10. At the same time, the non-display area electrode 8 is formed at the outer periphery of the display portion. Then, on the pixel electrode 9 and the non-display area electrode 8, an insulating layer 15 is formed (Figure 5(a)). Next, on the insulating layer 15, the partition wall 2 and the structure 3 are formed and at the surfaces of the partition wall 2 and the structure 3, the common electrode layer 7 and the electrode layer 6 for

structure are formed, respectively, so that they are flush with each other. Then, the resultant surface is covered with an insulating layer (not shown) (Figure 5(b)).

Thereafter, the insulating liquid 11 and the electrophoretic particles 5 are uniformly filled in each pixel 4 in the display area (Figure 5(c)). During the filling, an amount of the insulating liquid 11 is adjusted so that the insulating liquid 11 is adjusted so that the insulating liquid 11 flows over the partition wall2 so as not to leave air in the pixel 4. The filling can be performed by means of a cylindrical nozzle, a slit nozzle, etc. The filling of the electrophoretic particles 5 using these nozzles is performed by close control, whereby the electrophoretic particles 5 are disposed substantially uniform in each pixel 4 in the display area. However, at the peripheral portion of the filling area, the filling is liable to become nonuniform. This is because ejection of the insulating liquid 11 and the electrophoretic particles 5 from the nozzle is not stabilized so quickly. Accordingly, in order to stably perform uniform filling in the display area, it is necessary to ensure a stabilization area for filling the insulating liquid 11 and the electrophoretic particles 5 at the peripheral portion of the display area. The structure 3 can also

function as the stabilization area.

Next, each pixel 4 is sealed by the second substrate 12. At the time of performing the sealing with the second substrate 12, an AC voltage having an appropriate frequency is applied between the common electrode 7 and the electrode layer 6 for structure and between the pixel electrode 9 and the non-display area electrode 8, whereby it becomes possible to leave the filled electrophoretic particles 5 between the common electrode 7 and the pixel electrode 9. On the other hand, also at the peripheral portion of the display area, the insulating liquid 11 and the electrophoretic particles 5 are present. However, the peripheral portion has the above described shape, such as the mesh shape, the line shape, the dot shape, or the like, by the projection portion 3a of the structure 3, so that it is possible to hold the electrophoretic particles 5 at the recess portion 3b between the electrode layer 6 for structure and the non-display area electrode 8. As a result, it becomes possible to remove the electrophoretic particles 5 from a contact (bonding) interface between the second substrate 12 and the upper surfaces of the partition wall 2 and the projection portion 3a of the structure 3 without leaving the electrophoretic particles 5 at the contact interface, and it is possible to prevent an occurrence of sealing defect due to the presence

of the electrophoretic particles at the contact interface. Further, by the presence of the structure 3, it is possible to ensure a sufficient adhesive (fixing) strength between the second substrate 12 and the first substrate 1. At the time of the sealing with the second substrate 12, when the second substrate 12 has a flexibility, in such a state that one end of the flexible second substrate 12 is bonded or fixed onto the first substrate 1, the other end of the flexible second substrate 12 is raised and closely pressed against the upper surfaces of the projection portion 3a (of the structure 3) and the partition wall 2 while pushing out an excessive insulating liquid 11, thus being bonded and fixed to the structure 3 or the first substrate 1 at the other end of the second substrate 12. When the second substrate 12 is a rigid member, the rigid second substrate 12 is closely disposed on the structure 3 and the partition wall 2 as it is and a peripheral and portion of the second substrate 12 is bonded and fixed to the first substrate 1. The thus prepared structure is connected with a voltage application circuit to provide a display apparatus (Figure 5).

Then, materials and other production process will be described.

As the first substrate 1 and the second substrate 12, it is possible to use: films of plastics,

such as polyethylene terephthalate (PET), polycarbonate (PC), polyether sulfone (PES), etc.; glass; quartz; stainless steel; and the like. As the substrate or a support of the substrate to be disposed on the observer side, it is necessary to use a transparent material. However, in the case of an electrophoretic display apparatus of a reflection-type, the other substrate may be a colored film, such as PI film.

In the case where the common electrode 9 also functions as the reflection layer, it is preferable that the pixel electrode 9 is formed of a material having a high light-reflective property, such as silver, aluminum, etc. As a method of scattering incident light, as described above, it is possible to use the method wherein the pixel electrode 9 is provided with the surface unevenness for scattering.

As the insulating liquid 11, it is preferable that a nonpolar and transparent solvent, such as isoparaffin, silicone oil, xylene, toluene, or the like is used. It is also possible to use the electrophoretic particles 5 without employing the liquid.

As the electrophoretic particles 5, it is preferable that particles of a material having a good positive or negative chargeability in the insulating liquid are used. For example, it is possible to use

particles of various inorganic or organic pigments, carbon black, and resins containing these pigments. The electrophoretic particles 5 may generally have a particle size of approximately 0.01 - 50 μm, preferably approximately 0.1 - 10 μm, more preferably approximately 0.5 - 5 μm.

Incidentally, in the insulating liquid 11 or the electrophoretic particles 5, it is also possible to add a charge control agent for controlling and stabilizing an electrical chargeability of the electrophoretic particles 5 and a dispersing agent for preventing agglomeration of the electrophoretic particles 5 and retaining a dispersion state.

The partition wall 2 and the structure 3 may be formed by any method, such as a method wherein a photosensitive resin layer is applied and then subjected to light exposure and wet development, a method wherein a partition wall 2 and a structure 3 which are prepared separately are bonded; printing method; etc.

In the above description, the particle movement-type display apparatus is explained with respect to the electrophoretic display apparatus but the present invention is also applicable to a so-called toner display for effecting display by driving only particles without using the liquid.

[Example]

Hereinbelow, the present invention will be described more specifically based on Examples.

(Example 1)

In this example, an electrophoretic display apparatus has a structure shown in Figures 1(a) and 1(b). The electrophoretic display apparatus is prepared in the following manner. A first substrate 1 provided with TFTs, wiring, and the like is prepared. On the first substrate 1, an insulating layer is formed so as to provide a contact hole with respect to an associated TFT 10. At a portion for forming a pixel electrode 9, an unevenness is formed of a resist and thereon the pixel electrode 9 is formed in a film of aluminum, followed by patterning through photolithography. At the same time, a non-display area electrode 8 is formed at a peripheral portion of a display area. Then, on the pixel electrode 9 and the non-display area electrode 8, a transparent insulating layer 15 is formed.

Thereafter, at a boundary portion of each portion 4 formed in the display area, a partition wall 2 is formed in a width of 5 μm and a height of 15 μm. At the same time, at a periphery of the display area, a mesh-shaped structure 3 is formed in a width which is 20 times the size of pixel 4. In this case, the structure 3 has a projection portion 3a having the same width and height as the partition wall 2. The

width of the projection portion 3a is sufficiently smaller than a width which is approximately 10 times of a diameter of the electrophoretic particles 5. The structure 3 has a mesh pitch of 1/2 of a pitch of partition wall 2 in a pixel area. Thereafter, a metal layer is formed and patterned on the surfaces of the partition wall 2 and the structure 3 to form a common electrode 7 and an electrode 6 for structure. On the surfaces of these electrodes 7 and 6, in insulating layer is formed.

Next, the pixel electrode 9 and the non-display area electrode 8 are caused to have the same potential and between these electrodes 9 and 8 and between the electrodes 7 and 6, a voltage of ±10 V is applied at a frequency of 500 Hz. In the voltage application state, an insulating liquid 11 and electrophoretic particles 5 are filled in each pixel 4 by using nozzles. As a result, the electrophoretic particles 5 are not present on the upper surfaces of the partition wall 2 and the structure 3 by the AC voltage application and are collected between adjacent partition wall portions, between adjacent projection portions 3a, or between the partition wall and the projection portion 3a. In this state, each pixel 4 is sealed with a second substrate 12. The resultant display device is connected with a voltage application circuit to provide a display apparatus.

The resultant display apparatus can suppress sealing defect occurring due to the presence of the electrophoretic particles 5 sandwiched between the second substrate 12 and the partition wall 2 and between the second substrate 12 and the projection portion 3a of the structure 3, while ensuring a strength.

(Example 2)

In this example, similarly as in Example 1, on first substrate 1, TFTs, wiring and the like, an insulating layer, a pixel electrode 9, and a non-display area electrode 8 are formed.

Thereafter, at a boundary portion of each portion 4 formed in the display area, a partition wall 2 is formed in a width of 5 μm and a height of 15 μm. At the same time, at a periphery of the display area, a line-shaped structure 3 is (Figures 2 and 3). In this case, the structure 3 has a projection portion 3a having the same width and height as the partition wall 2. Thereafter, a metal layer is formed and patterned on the surfaces of the partition wall 2 and projection portion 3a of the structure 3 to form a common electrode 7 and a non-display area electrode 8. On the surfaces of these electrodes 7 and 8, in insulating layer is formed.

Next, the pixel electrode 9 and the non-display area electrode 8 are caused to have the same potential

and between these electrodes 9 and 8 and between the electrodes 7 and 8, a voltage of ±15 V is applied at a frequency of 500 Hz. In the voltage application state, an insulating liquid 11 and electrophoretic particles 5 are filled in each pixel 4 by using cylindrical nozzles. As a result, the electrophoretic particles 5 are not present on the upper surfaces of the partition wall 2 and the structure 3 by the AC voltage application and are collected between adjacent partition wall portions, between adjacent projection portions 3a, or between the partition wall and the projection portion 3a. In this state, each pixel 4 is sealed with a second substrate 12. The resultant display device is connected with a voltage application circuit to provide a display apparatus.

The resultant display apparatus can suppress sealing defect occurring due to the presence of the electrophoretic particles 5 sandwiched between the second substrate 12 and the partition wall 2 and between the second substrate 12 and the projection portion 3a of the structure 3, while ensuring a strength.

[Industrial Applicability]

The display apparatus of the present invention can be used in various electronic equipment, such as a mobile-type personal computer (information processor). The personal computer is constituted by a main

assembly portion, provided with a keyboard, and the above described display apparatus. The display apparatus is also applicable to a display portion of cellular phone which is provided with a plurality of operating buttons, a receiving portion, a transiting portion (mouthpiece), and the above described display apparatus. Further, the display apparatus is applicable to a finder for a digital still camera which is provided with a light-receiving unit including an optical lens, CCD, etc., on the observer side. In the digital still camera, a light image of a subject is photoelectric-converted into an imaging signal by an image pickup device, such as the CCD. At a back surface of a casing of the digital still camera, the above described display apparatus for effecting display on the basis of the imaging signal by the CCD is disposed and functions as the finder. The display apparatus of the present invention is further applicable to electronic book, electronic paper, a liquid crystal television, a car navigation apparatus, electronic notepad, equipment provided with a touch panel, and so on.

[Brief Description of the Drawings]

Figures 1(a) and 1(b) are plan view and a sectional view, respectively, for illustrating a particle movement-type display apparatus according to an embodiment of the present invention.

Figure 2 is a plan view for illustrating a particle movement-type display apparatus according to another embodiment of the present invention.

Figure 3 is a plan view for illustrating a particle movement-type display apparatus according to another embodiment of the present invention.

Figure 4 is a plan view for illustrating a particle movement-type display apparatus according to another embodiment of the present invention.

Figures 5(a) to 5(d) are sectional views for illustrating an embodiment of a process for producing a particle movement-type display apparatus according to the present invention.

Figure 6 is a plan view for illustrating a particle movement-type display apparatus according to another embodiment of the present invention.

[Reference Numerals]

1: first substrate
2: partition wall
3: structure
3a: projection portion of structure
3b: recess portion of structure
4: pixel portion
5: electrophoretic particle
6: electrode layer for structure
7: common electrode
8: non-display area electrode

9: pixel electrode

12: second substrate

[ DOCUMENT NAME ] DRAWINGS

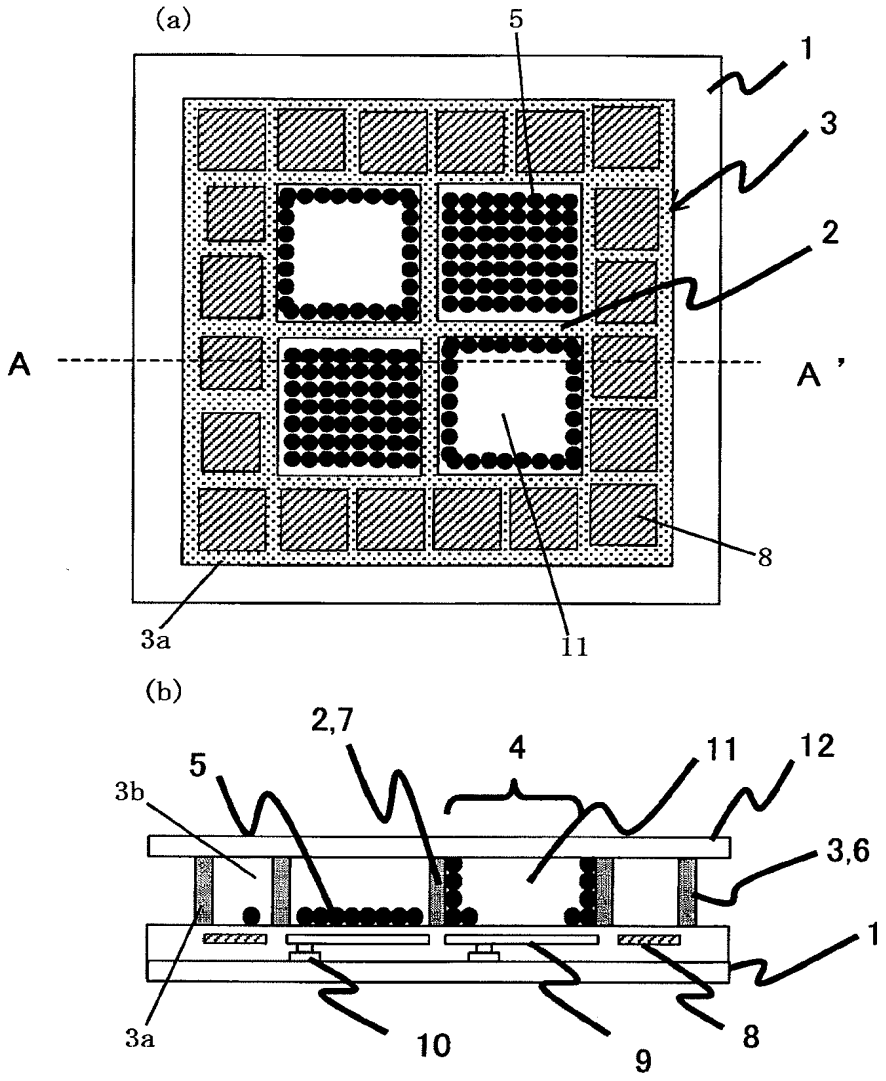


FIG. 1

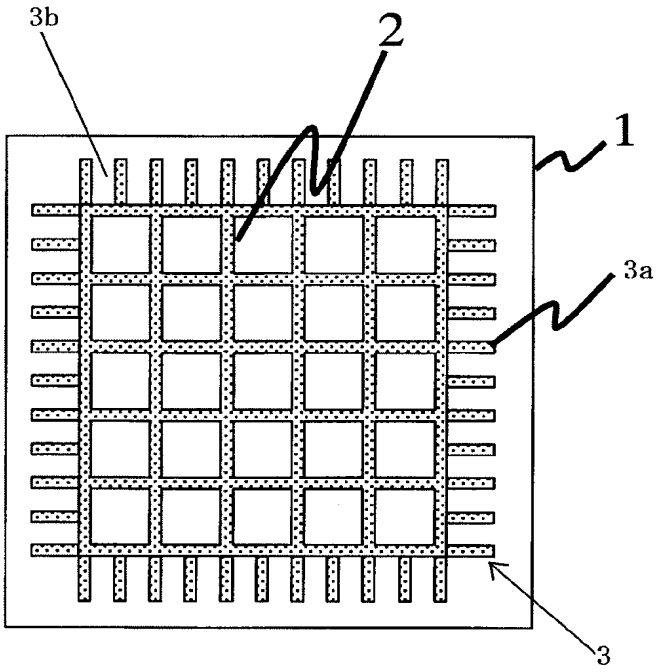


FIG. 2

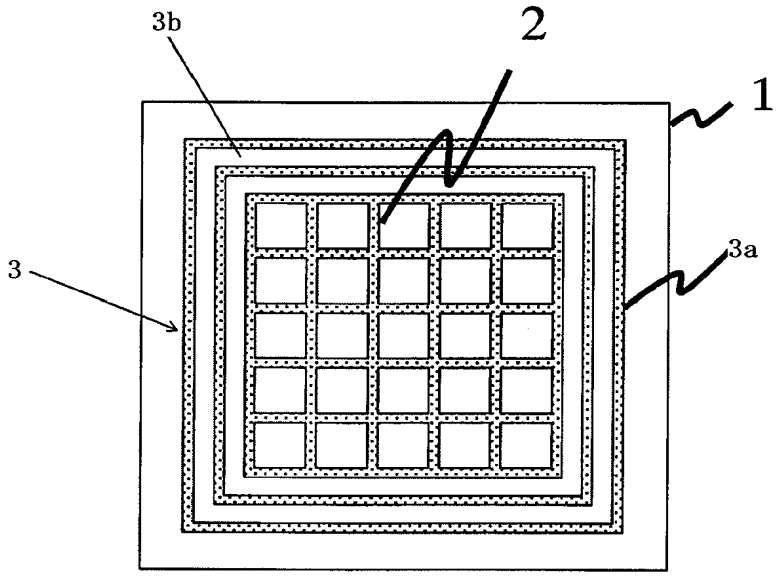


FIG. 3

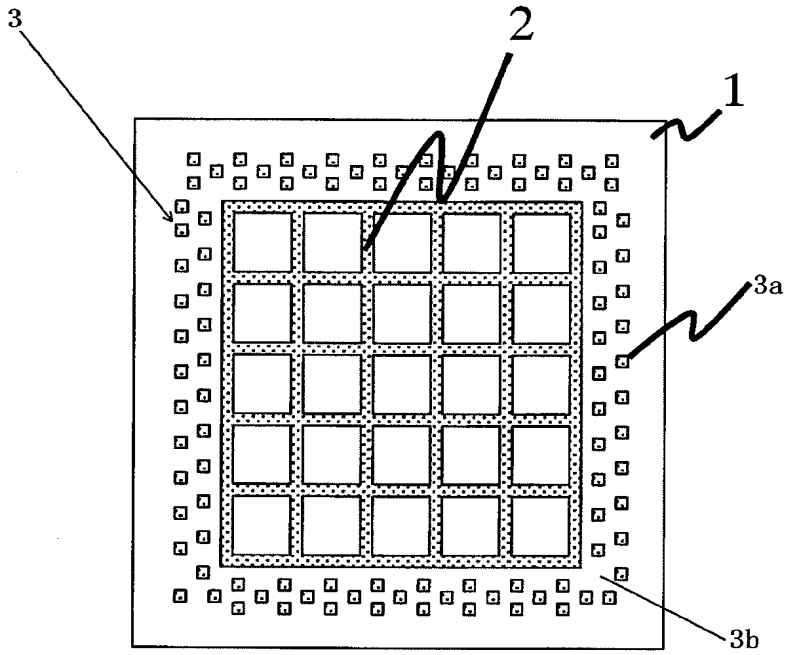


FIG. 4

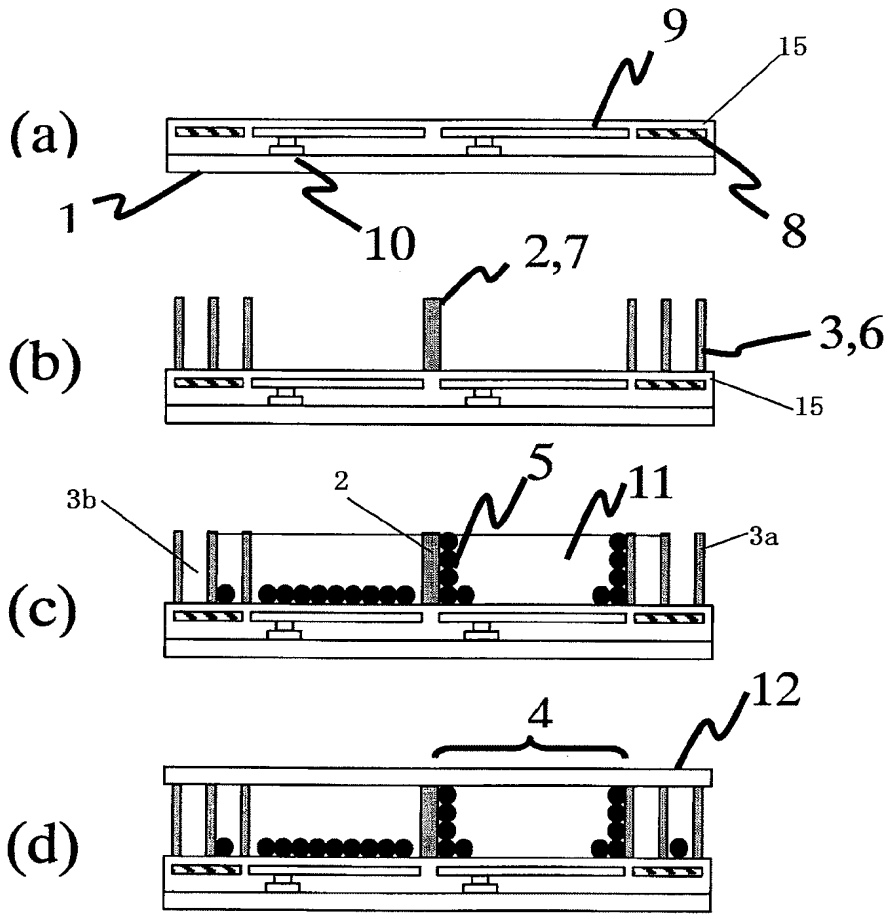


FIG. 5

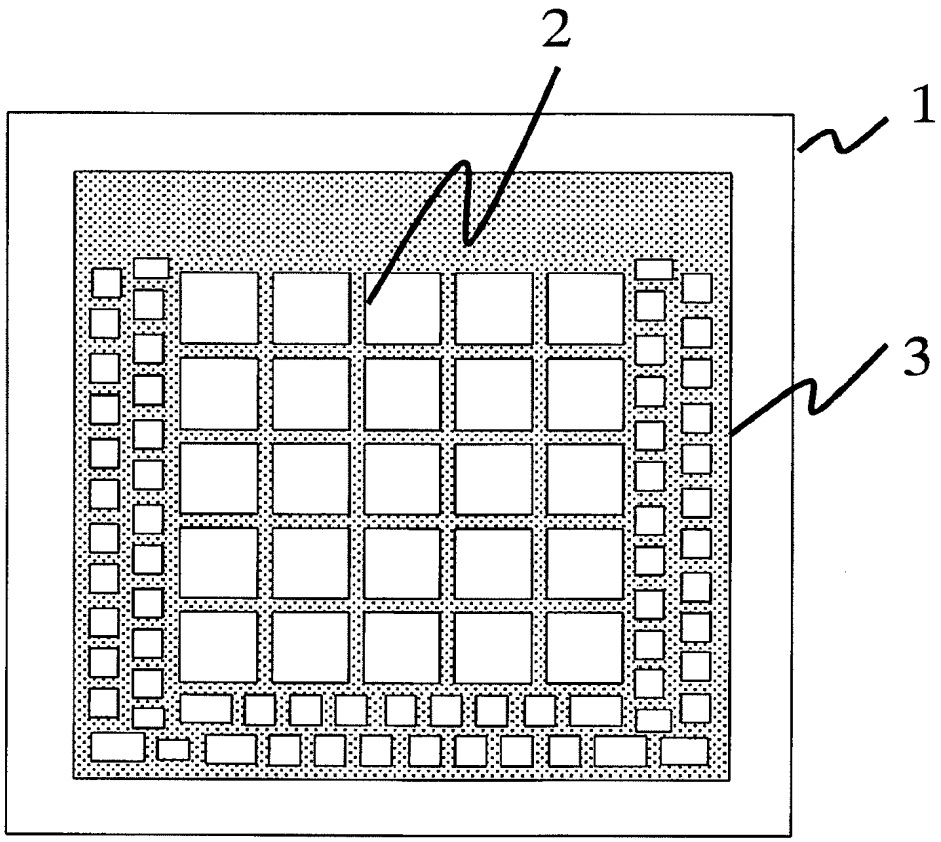


FIG. 6

[Document]

Abstract

[Abstract]

[Object]

It is a principal object of the present invention to provide a particle movement-type display apparatus provided with a structure for suppressing the defect occurring due to the presence of the particles sandwiched between the unnecessary portions.

[Means for Solving the Problems]

There is provided a particle movement-type display apparatus comprising: a first substrate 1 and a second substrate 12 with a predetermined spacing between the first substrate 1 and second substrate 12; a partition wall member 2 disposed in the spacing between the first substrate 1 and second substrate 12; a plurality of particles disposed in the gap surrounded by the substrates and the partition wall member 2; a plurality of pixel portions 4 formed by a plurality of electrodes 7 and 9 disposed internally in contact with the spacing; and wherein the apparatus further comprises a structure 3, which has a projection portion 3a having a height substantially equal to a height of the partition wall member 2 and a recess portion 3b in which a part of the particles 5 are capable of being accommodated, disposed in at least a part of an outer peripheral portion around a

display portion comprising a plurality of pixel portions 4.

[Selected Figure]

Figure 1